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# The potential demography: a tool for evaluating differences among countries in the European Union

## 1. INTRODUCTION

Potential demography is grounded in the theoretical assumption that the future is similar to an economic good. Therefore, a population that owns more future will be wealthier. The future of a population at any given time can be evaluated by calculating its "potential life", that is the sum of life expectancies of its members, or *demographic asset* (*DA*). In a given period, usually a year, the variation of *DA* can be computed: it derives from the number of the additional potential years of life that a population "creates" and adds to the asset, discounting what is consumed (living) or lost (dying), plus or minus what is transferred to or received from other populations. Therefore, during a year, *DA* increases by a gross additive amount through births and net migrations[1], or *demographic gross domestic product* ($_dGDP$), while it decreases by the simple "consumption" of the remaining years of life (due to time flow) and by deaths.

Hence, unlike in classic demography, in the framework of potential demography each individual in the population is counted not as, simply, one but in proportion to the individual's life expectancy at age $x$. This has many implications based on the assumption that the youngest are worth more than the eldest; and that, for example, regardless of the costs connected to their "production" and maintenance, newborns have a greater value for the community than immigrants, since their life expectancy is higher. Furthermore, the differences in a population's *DA* derive not only from their different age structures or fertility/survival profiles, but also from their ability to hold/attract other populations (net migrations).

The importance of the message of potential demography (Hersch, 1940; 1942; 1944a; 1944b; 1948; 1949; 1950) has been ignored for a long time, primarily due to the unavailability of basic data on life tables, population structure by sex and age, and migration flows. Any resulting analysis was minimally useful for comparative purposes.

In light of the wide range of up-to-date and geographically detailed data currently available, in this paper we intend to revisit the potential demography approach. We offer the reader an evaluation of the stock-and-flow demograph-

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[1] This additive amount can be negative, as occurs when net migration balance is negative and greater than the number of births.

ic variables complementary to the classic ones in order to, on the one hand, explain the differences among populations, simultaneously in size and structure, and, on the other hand, to measure the impact of natural balance and migration balance on the "future" of populations. The study considers data from 27 European countries in 2010.

Furthermore, we suggest a re-reading of the economic debt for the 27 European countries, in relation to the main stock (*DA*) and flow ($_{d}GDP$) measurements of potential demography. This would provide insights into the differences that appear when potential demographic quantities are employed rather than the standard ones, with regard both to the ability of the population of each country to deal with its financial commitments and to the countries' relative positions.

## 2. BACKGROUND

The concept of potential demography originates in Liebman Hersch's studies. In his first paper on this subject (1940), he was pioneering what is now an elementary notion of demography: population composition (notably by age) is far more important than its size. He formulated the concept of demographic vitality as the individual ability to live for a longer or shorter length of time. Starting with this definition, he stated the need to "weigh" every demographic event (birth, death, migration)[2] with the individual's expected residual life. In Frumkin's (1956) words, in Hersch's time demography had an essentially descriptive character, aimed at comparing different populations by means of techniques of standardization; in Hersch's studies (1944a, 1944b) we find the seeds of future development toward a probabilistic discipline. Expanding the horizon to the broader concept of "demographic potential" (Ediev, 2001), many scholars, beginning with Fisher (1930), Vincent (1945), Bourgeois-Pichat (1951), Boldrini (1956), Keyfits (1968, 1971), and Tognetti (1976), contributed to further developing this subject, although in different directions. They all concentrated on the potential inherent to a population state, while Hersch's original idea was not well pursued by other demographers.

Then, in his second work, Hersch (1942) completed the architecture of the potential demography model. He reviewed the annual balance of a population in terms of gains and losses of years of life, looking at the problem from the point of view both of the people to count (the total population or a particular subgroup) and the length of life to consider (the total life or a part of it such as active life, retirement age, and so on)[3]. His suggestion to consider potential years of life

[2] As Hersch suggested in his first paper, this approach can be applied to every demographic event, including indirect ones such as marriage, when a suitable survival table is available.

[3] Some interesting tools are suggested in those pages, such as the female procreation demographic product, which consists of the number of years of life gained or lost during a year by the female population of reproductive age, which expresses a high-performing measurement of demographic dynamism.

instead of number of people was welcomed by Mentha (1948), who applied it to the study of mortality by causes of death. Hersch's work on aging hinted at this (1948) and, later, Mentha, Hersch himself (1949), Branco (1950), and Sailer (1951) elaborated on the concept. In the following decade, Hersch's basic concepts evolved into calculating the potential years of life lost (*PYLL*) by causes of death by a group of American scholars - Greville (1948), Dickinson and Walker (1948), Haenszel (1950), Doughty (1951) - as well as by British academics Stocks (1953) and Logan and Benjamin (1953), among others. Thereafter Hersch's potential demography was ignored until the end of the 1980s, when the *PYLL* calculation was recovered by the U.S. Centers for Disease Control and Prevention (1986, 1989) and, in the same years, by Arcà *et al.* (1988) for Italy; by Garcia-Rodriguez and da Motta (1989) for Spain and Portugal, and by Meade (1980) for Southeast Asia. More recently, some developments of the *PYLL* calculation refer to risk factors (Pollard, 1988, 1990; Caselli, 1991) or, more generally, to the social determinants of health rather than causes of death. A well-detailed review of these studies is included in Panush and Peritz's work (1996) on potential demography.

In 1948, Hersch published a paper dedicated to investigating population aging by means of potential demographic tools, as compared with the classic demographic indexes. For example, he introduced the concept of a "vital center" of a population as the age that divides the sum of potential years of life of a population into two equal parts), demonstrating that potential demography is more effective in detecting the aging level of a population. This subject was deepened in his subsequent research on the law of counterbalance of losses due to mortality by losses due to advancing age. The research front addressing the increase in life expectancy by aging population inspired many demographers in the following decades: Fries (1980), Manton, Stallard, and Trolley (1991), Oeppen and Vaupel (2002), Sanderson and Scherbov (2005, 2006), Bongaarts (2006), Carnes and Olshansky (2007), and Lutz, Sanderson, and Scherbov (2008), to mention the main contributions.

As far as the scope of this paper is concerned, what is interesting in Hersch's last two papers is that potential demography tools are proven to be more effective in comparisons both between different populations, and in the same populations at different times. Age structure and vital expectations, the two faces of the aging profile that are evaluated separately by classic demography, could be synthesized in a single index by potential demography (by means of the so-called generalized mean age), allowing comparison among the aging levels of different populations. The emphasis on comparison is essentially the thread that links all of Hersch's works in potential demography: starting with Belgium versus the Netherlands in his first work (1940), continuing with Switzerland at different times (1942), then with a pool of eight countries - Belgium, France, Germany, Italy, Netherlands, Sweden, Switzerland, and the United Kingdom (1948) - and again with Switzerland at different times (1950).

Very recently, and following the same thread, Blangiardo (2012) proposed a review of Hersch's studies. Using the potential demography framework, Blangiardo describes the growing contribution foreign immigrants make to the Italian demographic asset (the sum of years of life for a population to live, as defined in the next paragraph) and suggests a way to compare the contribution of net migrations to the hosting populations of France, Germany, and Italy in terms of years of life gained/lost.

The present paper recovers Hersch's original ideas of potential demography, reviews the methodology to take account of the data currently available (Section 2), suggests alternative (or at least complementary) tools to describe the structure and dynamics of populations of different countries (Sections 3 and 4), and evaluates their ability to meet their financial commitments, commensurate to the amount of "future" a population owns and to the one it creates every year (Section 5).

## 3. DATA AND METHODS

Given the assumption that for a population the future is similar to an economic good, the amount of future of a population (*DA*) depends on its structural characteristics (sex and age), inherited from the past as a result of a process of annual adjustments determined by flows of individuals entering or leaving the population, and by its registered survival levels[4].

Formally,

$$DA\ (1.1.t)=\sum_s \sum_x P_x^s\ (1.1.t)\cdot\tilde{e}_x^s \quad s=m,f;\ x=0,1,\cdots,\omega\text{-}1 \qquad [1]$$

where is $P_x^s(1.1.t)$ the population and $\tilde{e}_x^s$ the life expectancy[5] for each sex *s* at age *x* (years)[6] being ω-1 the hypothetical last birthday of life.[7]

The annual additive contribution to *DA* computed at time 1.1.*t*+1, comes

[4] Supposedly valid in the future.

[5] From an appropriate current life table. The assessment here is considered independent of any future change in the duration of life.

[6] The life expectancy $\tilde{e}_x^s$ at age *x* relates to the person's age at last birthday, between exact age *x* years and exact age *x*+1 years.

[7] It can be argued that the years of potential life of individuals do not all have the same value, depending on the intended use of those years. Therefore, one further year at age 86 years has a different value than one at age 40 years, when the ability to work, for example, is considered. On the other hand, from an individual's point of view, the remaining life tends to be more valuable as the age increases. For the sake of simplicity, the hypothesis that the years of life are independent of their "usefulness" has been adopted. Hence, the total asset resolves in the simple sum of the potential years of life left to live in the community.

from two components. The first one consists of the product of the number of births, net of infant mortality and migration balance (i.e. $P_0^s(1.1.t)$ ), by their life expectancy. The second component consists of the product of the net balance between individuals who joined or left the population during the previous year, being at a given age $x$ years at time 1.1.$t$+1, by their corresponding life expectancy[8].

The increase registered for the *DA* of a population during a period, usually a year, can be interpreted as the production of a net "income", which is the number of additional potential years of life that the population "creates" and adds to the asset, discounting what it spends to produce the income itself.

The "gross" income (i.e. the additional future created) is generated in two ways: through births, which represent the highest contribution per unit of additional potential years of life created annually, and through net migrations[9]. This second component is included in the gross income since the choice of a future-oriented perspective allows net migration to be considered as an outcome of population, deriving from its ability to attract immigrants, on the one hand, and to hold potential emigrants, on the other hand.

Therefore, assimilating annual "production" of years of future life to the notion of the *economic gross domestic product* (*GDP*), the corresponding amount will be termed the *demographic gross domestic product* (${}_dGDP$).

Then,

$$ {}_dGDP(t,t+1)=\sum_s P_0^s(t+1)\cdot \tilde{e}_0^s+\left\{\sum_s\sum_x [I_x^s(t,t+1)\text{-}E_x^s(t,t+1)]\right\}\cdot\tilde{e}_{x+1}^s \qquad [2] $$

$s=m,f;\ x=0,1,\cdots,\omega\text{-}2$

where $I_x^s(t,t+1)$ and $E_x^s(t,t+1)$ are the immigration and emigration flows in the period $(t,t+1)$ by sex ($s$), age ($x$) and time ($t$).

Finally, the decrease of *DA* occurs both for the simple "consumption" of the remaining years of life (due to time flow) and for the losses due to deaths. Therefore, the annual expenditure of demographic product (${}_dC$) consists of the total years of life lost by deaths and of time consumed by people still living and present in the population at the end of the year:

[8] Here we assume that people entering the population immediately acquire the same survival levels as the native population. However, this hypothesis could be somewhat misleading due to both the intense flows of immigrants coming from highly disadvantaged countries and the selective effects of migration on health status (so-called healthy migrant selection).

[9] See note 1.

$$ {}_{d}C(t,t+1)=\sum_{s}\sum_{x} M_x^s(t,t+1)\cdot\tilde{e}_{x+1}^s+\sum_{s} M_{\omega\text{-}1}^s\cdot\tilde{e}_{\omega\text{-}1}^s+ $$

$$ +\sum_s\sum_x P_x^s(1.1.t)\cdot\left[\tilde{e}_x^s\text{-}\tilde{e}_{x+1}^s\right]+\sum_s P_{\omega\text{-}1}^s(1.1.t)\cdot\tilde{e}_{\omega\text{-}1}^s \qquad [3] $$

$$ s=m,f;\ x=0,1,\cdots,\omega\text{-}2 $$

where $M_x^s(t,t+1)$ are the deaths by sex and age registered in the period $(t,t+1)$.

The three measurements *DA*, ${}_{d}GDP$, and ${}_{d}$C are computed for each of the 27 European countries: *DA* at time 1.1.2010 and ${}_{d}GDP$ and ${}_{d}$C during the year 2010.

Based on the assumption that *DA* and ${}_{d}GDP$, are stock and flow measurements, respectively, of the time-future of a population, ratios with the economic dimensions (notably debt) are also presented. More specifically, two ratios are computed: 1) the ratio between the debt of each country and its *DA* aims to show the amount of the debt bearing on each potential year of life of the individuals present in the current population; 2) the ratio between the debt and ${}_{d}GDP$ aims to account for the annual cost of the debt when bearing only on the net flows added to the population during the year[10].

## 4. POPULATION AND DEMOGRAPHIC ASSET IN EUROPEAN COUNTRIES

Consideration of the demographic asset for the 27 European countries instead of simply population implies some significant differences when evaluating the relative importance of each country, both in static and dynamic terms.

Based on the premises of potential demography[11], each individual is counted, not as 1, but in proportion to life expectancy at age *x*, so that the youngest are worth more than the eldest. For example, in the case of France, a newborn male counts[12] twice as much as a man aged 41 years, four times as much as a man aged 63 years, and sixteen times as much as a man aged 86 years.

On 1.1.2011, Germany, France, the United Kingdom and Italy represent the most important countries, in decreasing order, by demographic asset: they form almost 54% of the European Union total asset (Table 1).

[10] In the first case, we measure the ability of a country (or population) to offer, as a guarantee on the debt, the existence today of a (more or less) large amount of future (consisting of work and productivity) in order to eliminate that debt. In the second case, the debt is related to the flow of vitality through which each country/population is able to annually create its own future (made up of work and productivity) to pay off the debt.

[11] See the introduction.

[12] At the survival levels of 2009.

Table 1 – *Population and Demographic Asset in European countries*

| | Population | | | Demographic Asset (*DA*) | | |
|---|---|---|---|---|---|---|
| | (thousands) 1.1.2011 | % of EU pop. | Var.% 1.1.2010 -1.1.2011 | (million years of life) 1.1.2011 | % of EU *DA* | Var. % 1.1.2010 – 1.1.2011 |
| Austria | 8,404.3 | 1.7 | 0.3 | 347 | 1.7 | -0.1 |
| Belgium[a] | 10,839.9 | 2.2 | 0.8 | 451 | 2.2 | 0.6 |
| Bulgaria | 7,504.9 | 1.5 | -0.8 | 267 | 1.3 | -1.1 |
| Cyprus[a] | 803.1 | 0.2 | 0.8 | 36 | 0.2 | 0.3 |
| Czech Republic | 10,532.8 | 2.1 | 0.2 | 413 | 2.0 | -0.1 |
| Denmark | 5,560.6 | 1.1 | 0.5 | 229 | 1.1 | 0.2 |
| Estonia | 1,340.2 | 0.3 | 0.0 | 51 | 0.3 | -0.3 |
| Finland | 5,375.3 | 1.1 | 0.4 | 221 | 1.1 | 0.1 |
| France[b c] | 63,136.2 | 12.6 | 0.5 | 2,752 | 13.4 | 0.2 |
| Germany | 81,751.6 | 16.3 | -0.1 | 3,208 | 15.6 | -0.6 |
| Greece[b] | 11,309.9 | 2.3 | 0.0 | 470 | 2.3 | -0.4 |
| Hungary | 9,985.7 | 2.0 | -0.3 | 367 | 1.8 | -0.7 |
| Ireland | 4,480.9 | 0.9 | 0.3 | 209 | 1.0 | -0.1 |
| Italy | 60,626.4 | 12.1 | 0.5 | 2,436 | 11.9 | 0.1 |
| Latvia | 2,229.6 | 0.4 | 0.8 | 81 | 0.4 | -1.4 |
| Lithuania | 3,244.6 | 0.6 | -2.5 | 120 | 0.6 | -3.4 |
| Luxembourg | 511.8 | 0.1 | 1.9 | 22 | 0.1 | 1.7 |
| Malta | 417.6 | 0.1 | 0.8 | 18 | 0.1 | 0.1 |
| Netherlands | 16,655.8 | 3.3 | 0.5 | 709 | 3.5 | 0.1 |
| Poland | 38,200.0 | 7.6 | 0.1 | 1,517 | 7.4 | -0.4 |
| Portugal | 10,637.0 | 2.1 | 0.0 | 430 | 2.1 | -0.5 |
| Romania[a] | 21,462.2 | 4.3 | -0.2 | 808 | 3.9 | -0.6 |
| Slovakia | 5,435.3 | 1.1 | 0.2 | 214 | 1.0 | -0.3 |
| Slovenia | 2,050.2 | 0.4 | 0.2 | 83 | 0.4 | -0.3 |
| Spain | 46,152.9 | 9.2 | 0.4 | 1,981 | 9.7 | -0.1 |
| Sweden | 9,415.6 | 1.9 | 0.8 | 401 | 2.0 | 0.7 |
| United Kingdom[b] | 62,435.7 | 12.5 | 0.7 | 2,670 | 13.0 | 0.5 |
| Total EU | 500,500.0 | 100.0 | 0.3 | 20,511 | 100.0 | -0.1 |

[a] 2009.
[b] Results for 2010 are based on 2009 life tables.
[c] Territory of metropolitan France.
*Source*: Elaboration of Eurostat data.

Of the countries that benefit from the change of perspective in ranking by demographic asset instead of population, France shows the greatest gain (from 12.6% to 13.4% of the European Union total). It is followed by the United Kingdom, whose relative importance increases to 13%, and Spain (+0.5). Less apparent but still significant is the increase in the Netherlands - (+0.2) and finally Ireland and Sweden (+0.1). On the other hand, Germany tops the list of the most penalized countries, with a loss of 0.7 points, followed by Romania (-0.4), Bulgaria, Hungary, Italy, and Poland (-0.2).

These preliminary outcomes are not totally unexpected. As a matter of fact, the positive differences observed for the first group of countries (the "gainers") must be ascribed to the favorable contingency of a population structure younger than the European average and to good performance in survival. On the other hand, the negative differences detected in the second group (the "losers") can be attributed to an older population structure (as in the case of Germany) and/or to lower survival perspectives (as in Romania)

Table 2 – *Population structure and survival levels in European countries: ranking by the decreasing percentage of 0-14 years old*

| | Population 1/1/11 | | | Life expectancy at birth (2010) | |
|---|---|---|---|---|---|
| | %0-14 | 15-64 | 65+ | Male | Female |
| Ireland | 21.8 | 66.6 | 11.6 | 78.5 | 83.0 |
| France[a b] | 18.3 | 64.7 | 16.9 | 77.8 | 84.7 |
| Denmark | 17.9 | 65.3 | 16.8 | 76.9 | 81.1 |
| Luxembourg | 17.6 | 68.5 | 13.9 | 77.7 | 83.2 |
| Netherlands | 17.5 | 67.0 | 15.6 | 78.7 | 82.7 |
| United Kingdom[a] | 17.4 | 66.0 | 16.6 | 78.1 | 82.3 |
| Belgium[a] | 16.9 | 65.9 | 17.2 | 77.1 | 82.5 |
| Cyprus[a] | 16.9 | 70.1 | 13.1 | 78.4 | 83.3 |
| Sweden | 16.6 | 64.9 | 18.5 | 79.3 | 83.3 |
| Finland | 16.5 | 66.0 | 17.5 | 76.5 | 83.2 |
| Estonia | 15.3 | 67.6 | 17.0 | 70.4 | 80.4 |
| Slovakia | 15.3 | 72.3 | 12.4 | 71.6 | 79.1 |
| Malta | 15.3 | 69.2 | 15.5 | 79.1 | 83.4 |
| Romania[a] | 15.2 | 69.9 | 14.9 | 70.0 | 77.5 |
| Portugal | 15.1 | 66.7 | 18.2 | 76.4 | 82.5 |
| Spain | 15.1 | 67.8 | 17.1 | 78.8 | 85.0 |
| Poland | 15.1 | 71.4 | 13.6 | 71.9 | 80.5 |
| Lithuania | 15.0 | 68.5 | 16.5 | 67.7 | 78.6 |
| Austria | 14.7 | 67.7 | 17.6 | 77.6 | 83.3 |
| Hungary | 14.6 | 68.7 | 16.7 | 70.5 | 78.4 |
| Czech Republic | 14.4 | 70.1 | 15.5 | 74.2 | 80.6 |
| Greece[a] | 14.4 | 66.4 | 19.3 | 77.8 | 84.7 |
| Slovenia | 14.2 | 69.3 | 16.5 | 76.1 | 82.8 |
| Italy | 14.0 | 65.7 | 20.3 | 78.6 | 83.8 |
| Bulgaria | 13.8 | 68.5 | 17.7 | 70.4 | 77.4 |
| Latvia | 13.7 | 68.9 | 17.4 | 68.4 | 78.2 |
| Germany | 13.4 | 66.0 | 20.6 | 77.7 | 82.7 |

[a] 2009.
[b] Territory of metropolitan France.
*Source*: Elaboration of Eurostat data.

(Table 2).

However, in the European context, the structural effects seem to be more important than survival variability[13] with respect to the framework of the potential demography.

## 5. THE DEMOGRAPHIC GROSS DOMESTIC PRODUCT

A number of interesting results become apparent when considering the annual production (or acquisition) of years of life for the populations of European countries (almost 474 million years of life in 2010, when combined).

At first glance, it should be noted (Table 3) that more than 56% of the entire $_{d}GDP$ of the European Union comes from the United Kingdom and France (15% from each), Germany (13%), and Italy (13%). There are substantial differences in the resulting ranking of total population, where Germany is clearly first (16% of the European Union's total population) while the other three countries are

Table 3 – *$_{d}GDP$ in 2010 for the European countries*

| | $_{d}GDP$ per capita | $_{d}GDP$ (million years of life) | | | | |
|---|---|---|---|---|---|---|
| | | Total | from cohorts of newborns[e] | from net migration flows | Consumed $_{d}C$ | Balance |
| Austria | 0.9 | 7.9 | 6.3 | 1.6 | 8.3 | -0.5 |
| Belgium[a] | 1.3 | 13.6 | 10.1 | 3.5 | 10.7 | 2.9 |
| Bulgaria | 0.6 | 4.4 | 5.2 | -0.8 | 7.4 | -3.0 |
| Cyprus[a] | 1.1 | 0.9 | 0.8 | 0.1 | 0.8 | 0.1 |
| Czech Republic | 0.9 | 10.0 | 9.1 | 0.9 | 10.5 | -0.5 |
| Denmark | 1.1 | 6.0 | 5.0 | 0.9 | 5.5 | 0.4 |
| Estonia | 0.9 | 1.2 | 1.2 | 0.0 | 1.3 | -0.1 |
| Finland | 1.0 | 5.6 | 4.9 | 0.7 | 5.3 | 0.3 |
| France[b c] | 1.1 | 69.2 | 64.4 | 4.8 | 62.6 | 6.6 |
| Germany | 0.8 | 62.5 | 54.4 | 8.1 | 81.5 | -19.0 |
| Greece [b] | 0.8 | 9.3 | 9.3 | 0.0 | 11.3 | -2.1 |
| Hungary | 0.7 | 7.1 | 6.6 | 0.5 | 9.9 | -2.8 |
| Ireland | 1.0 | 4.4 | 6.1 | -1.7 | 4.5 | -0.2 |
| Italy | 1.0 | 61.2 | 45.1 | 16.1 | 59.5 | 1.7 |
| Latvia | 0.5 | 1.1 | 1.4 | -0.3 | 2.2 | -1.2 |
| Lithuania | -0.3 | -0.9 | 2.6 | -3.5 | 3.3 | -4.2 |
| Luxembourg | 1.4 | 0.7 | 0.5 | 0.2 | 0.3 | 0.4 |
| Malta | 1.0 | 0.4 | 0.3 | 0.1 | 0.4 | 0.0 |
| Netherlands | 1.0 | 16.9 | 14.8 | 2.0 | 16.5 | 0.4 |
| Poland | 0.8 | 31.3 | 31.4 | -0.1 | 38.0 | -6.7 |
| Portugal | 0.8 | 8.2 | 8.0 | 0.2 | 10.6 | -2.4 |
| Romania[a] | 0.8 | 16.2 | 16.2 | 0.0 | 21.7 | -5.4 |

*...Cont'd...*

[13] The structural effects can be evaluated through appropriate methods of standardization.

Table 3 – *Cont'd*

| | $_dGDP$ per capita | $_dGDP$ (million years of life) | | | | |
|---|---|---|---|---|---|---|
| | | Total | from cohorts of newborns[e] | from net migration flows | Consumed $_dC$ | Balance |
| Slovenia | 0.9 | 1.8 | 1.8 | 0.0 | 2.0 | -0.2 |
| Spain | 1.0 | 45.3 | 40.6 | 4.7 | 46.7 | -1.4 |
| Sweden | 1.3 | 12.2 | 9.4 | 2.8 | 9.3 | 2.9 |
| United Kingdom[b] | 1.2 | 72.7 | 62.2 | 10.6 | 59.6 | 13.1 |
| Total EU[d] | 0.9 | 473.7 | 422.2 | 51.5 | 495.4 | -21.7 |

[a] 2009.
[b] Results for 2010 are based on 2009 life tables.
[c] Territory of metropolitan France.
[d] The total for the European Union is simply calculated as the sum of the countries.
[e] Births net of the infant mortality and migration balance (i.e. $P_0^s(1.1.t{+}1)$).
*Source*: Elaboration of Eurostat data.

equally represented (12%).

As for $_dGDP$ per capita, the United Kingdom and France (with 1.2 and 1.1 years per capita gained, respectively)[14] are among those countries showing the best performance, while Germany and Poland are the largest countries recording the worst scores with only 0.8 years of life per capita produced or acquired in 2010. Furthermore, according to Equation 2, the years of life gained by a population during a year come from both the cohorts of newborns and the net migration flows.

As for the contribution of the two components of $_dGDP$, three different patterns can be recognized. First, only four countries show a proportion of years gained by cohorts of newborns greater than 100% of the $_dGDP$: Ireland (138%), Latvia (132%), Bulgaria (118%), and, to a lesser extent, Poland (100.3%). This "natural overproduction"[15] is clearly counterbalanced by the negative role of net migration. This performance has a dramatic impact in Lithuania, where the modest contribution of the new cohort is not even sufficient to compensate for the sharp loss due to net migration, ultimately resulting in a negative $_dGDP$. In the second group of eleven countries showing a proportion of self-production of years of life higher than (or at least equal to) the European average (89%), but not over 100% of the $_dGDP$, France (93%) and Spain (90%) stand out significantly. For the remaining countries where the proportion of years of life resulting from net migration is higher than the European average (11%), Italy (26%), the United Kingdom (15%), and Germany (13%) show outstanding performance.

Furthermore, by analogy with the standard crude birth rate, it is possible to

[14] Only Luxembourg, Sweden, and Belgium show a slightly higher $_dGDP$ per capita.
[15] Given the interpretation of $_dGDP$ as a product, see Section 2.

calculate the *potential* birth rate as the ratio between the number of years gained by the cohorts of newborns and the demographic asset. In this case, the ratio achieves the maximum value for Ireland, with 29 years of life gained by newborns per 1,000 years of demographic asset, and the minimum value for Germany with only 17 years per 1,000. By adopting this perspective, certain countries (e.g. Sweden with 24 years gained per 1,000 years of demographic asset, and Italy with 19 years gained per 1,000 years), appear to show better performances than in terms of the classical crude birth rate.

Turning to the contribution of migration, an interesting comparison can be made between Italy and Spain. In both, the $_{d}GDP$ per capita is measured as one year: 26% of the gains are attributable to net immigration for the Italian population (16 million years of life, twice the amount observed for Germany and nearly four times that of France), while 90% is due to new cohorts in Spain.

Finally, regarding the balance between production and consumption/loss of years of life in 2010, a total negative balance of 22 million years is apparent across the entire European Union. Eleven of the 27 countries show a positive balance: the United Kingdom takes the lead with a contribution of 13 million years of life; France and Italy also display positive performances (+7 and +2 million years of life respectively). On the other hand, a negative balance is observed not only for the German population (-19 million years of life) but also for the majority of the eastern European countries: e.g. Poland (-7 million), Romania (-5), Lithuania (-4), Bulgaria, and Hungary (-3 million, respectively). Such negative results provide evidence of the serious difficulty these countries are likely to have maintaining their demographic asset over the coming years.

If the balance in terms of per capita is considered, Luxembourg is the clear leader with a net gain of 0.7 years, followed by Sweden, Belgium (+0.3 each), and the United Kingdom (+0.2). Finally, with a slightly positive balance (+0.1), France, Denmark, and Cyprus complete the list of countries that place over the bisector (i.e. production greater than consumption). At the other end of the scale, the population of Lithuania stays at the bottom with -1.3 years per capita. It is also worth pointing out that the annual balance of Italy and Spain is very close to zero (even though it is positive for Italy and negative for Spain), while Germany experiences a decrease of about 1/5 of a year per capita.

## 6. DEMOGRAPHIC BEHAVIOR AND ECONOMIC PERFORMANCE

Although the results presented in this paper are interesting in and of themselves, it is only when combined with the macroeconomic variables that potential demography reveals itself as a very powerful tool presenting a groundbreaking measurement to compare the countries of the European Union.

The theme of the interrelationship between economic and demographic development has been debated for a long time in both the economic and demographic literature but is still far from being solved. Although the theoretical and empirical relationship between economic development and demographic change has been quite clearly established, the correlation between demographic growth and per capita output is still ambiguous.

Since the early 1960s, the literature on this subject can be synthesized in terms of two opposite approaches: the neo-Malthusian scholars (Ehrlich, 1968) warn against the implications of overpopulation for the availability of non-renewable resources, while the libertarians (Boserup, 1965; Simon, 1998) believe in the "cornucopia" theory in which technological developments allow humanity to overcome the scarcity of resources.

Almost all scholars (see, for example, Lee, 1983; Kelley and Schmidt, 2001) agree that simple correlations between demographic and economic variables in cross-national studies are difficult to interpret, primarily because of reverse causality between economic and demographic change. However, demography does indeed matter when one considers the age structure of the population.

As is well documented in Lindh and Prskawetz's work (2011) on the interrelationship between demographic change and economic growth in the European Union over the past 50 years, demography has affected economic output in two ways. First, in the 1970s, when the baby boom generations entered the labor market, an accountability positive effect (which the authors called the "first dividend") was observed, due to the gap between the differential growth rates of population and the labor force. Second, the foreseen reversal between the growth rates of population and labor force, due to decreasing fertility, caused a behavioral effect (the "second dividend") in productivity, through the impact on savings[16], investments, and human capital (Bloom and Canning, 2001).

In synthesis, regardless of the models and the methods of estimation, the results of the studies are compatible: Bloom and Williamson (1998) find that population dynamics explain almost 20% of the economic growth over the period 1965-1990; Kelley and Schmidt estimate the contribution of the growth rate of population to the growth rate of output per capita in 1960-1995 at 24%.

Ultimately, regarding the objective of this paper, the scientific literature reveals that population matters when it is considered in its age group components and in its potential to create and maintain wealth.

To summarize, potential demography is grounded in the theoretical assumption that the future is similar to an economic good. It follows that a population that owns more future will be wealthier. Therefore, if *DA* and ${}_{d}GDP$ are accepted as, respectively, stock and flow measurements of the time-future of a population, the ratios with economic dimensions (notably the debt) have a cer-

[16] The increase in savings results as a response to the increases in life expectancies and bad prospects for income during retirement.

[17] Eventually, a more refined index can be computed using the expected working years instead of the whole expected life years.

tain informative value[17].

First, when the size of the debt of a country is related to its demographic asset, it expresses the ability of a population to meet its financial commitments, for the ratio indicates the amount of the debt bearing on each potential year of

Table 4 – *Main economic and demographic indicators for European countries in 2010*

| | General Government Debt (*GGD*) | | | |
|---|---|---|---|---|
| | Euro per capita (*GGD/P*) | Euro per year of life of total population (*GGD/DA*) | Euro per 100 *GDP* | Euro per year of life produced ($GGD/_dGDP$) |
| Austria | 24,626 | 594 | 72 | 26,102 |
| Belgium[a] | 30,195 | 723 | 96 | 24,030 |
| Bulgaria | 796 | 22 | 16 | 1,331 |
| Cyprus[a] | 12,500 | 278 | 59 | 10,925 |
| Czech Republic | 5,418 | 138 | 38 | 5,664 |
| Denmark | 18,386 | 445 | 43 | 17,103 |
| Estonia | 746 | 20 | 7 | 804 |
| Finland | 16,221 | 394 | 48 | 15,560 |
| France[b] | 25,267 | 578 | 82 | 23,007 |
| Germany | 25,215 | 643 | 83 | 32,990 |
| Greece | 29,096 | 700 | 145 | 35,571 |
| Hungary | 7,800 | 213 | 81 | 10,964 |
| Ireland | 32,183 | 689 | 92 | 33,130 |
| Italy | 30,471 | 757 | 118 | 30,129 |
| Latvia | 853 | 99 | 45 | . |
| Lithuania | 3,042 | 83 | 38 | . |
| Luxembourg | 15,781 | 364 | 19 | 10,971 |
| Malta | 9,616 | 222 | 69 | 9,939 |
| Netherlands | 22,269 | 522 | 63 | 21,923 |
| Poland | 5,107 | 129 | 55 | 6,238 |
| Portugal | 15,135 | 374 | 93 | 19,691 |
| Romania[a] | 1,304 | 35 | 24 | 1,722 |
| Slovakia | 4,972 | 126 | 41 | 5,791 |
| Slovenia | 6,834 | 169 | 39 | 7,653 |
| Spain | 13,935 | 324 | 61 | 14,169 |
| Sweden | 15,568 | 364 | 42 | 11,975 |
| United Kingdom | 21,741 | 507 | 79 | 18,606 |
| Total EU | 19,355 | 478 | 80 | 20,784 |

[a] 2009.
[b] Territory of metropolitan France.
"." negative values for $_dGDP$.
*Source*: Elaboration of Eurostat data.

life of every individual in the current population.

Second, the ratio between debt and $_dGDP$ (similar to the economic duration ratio debt/*GDP*) accounts for the annual cost of the debt when bearing only on the net flows added to the population during the year. While the debt/*DA* ratio tells you how much the debt it would annually cost people already present in the population, the debt/$_dGDP$ ratio tells you how much the net cohorts added during the year would be asked to pay per year (over the life-course) if they were the sole source to refaund the debt.

Therefore, relating the general government debt (*GGD*) (Table 4) to the demographic asset allows for an adjustment in the decreasing debt ranking of countries. The Irish population, which stays at the top with the highest value of debt (32,183 euro per capita), scales down to the fourth position, with 689 euro per years of life. The French population also benefits from this change, moving down from the 5th position (25,267 euro per capita) to the 7th position (578 euro per year of life). The German and Italian populations, on the other hand, share a certain disadvantage. Italy achieves the highest position in the ranking with 756 euro per year of life, and Germany moves ahead (from the 6th to 5th position) with 642 euro per year of life. No other significant shifts in the overall ranking are observed among the other countries.

An equally effective change of perspective can be obtained when comparing the amount of debt (*GGD*) to the demographic product (*dGDP*) instead of the usual economic *GDP* at current money values.

By comparing the scores in a decreasing ranking, several significant results emerge. Whereas the European Union (for which a total debt of 80% of *GDP* is calculated) shows an average value equal to 21,000 euro per year of life produced in 2010 ($_dGDP$), Germany (whose debt is 83% of *GDP*) ranks third with almost 33,000 euro, while Italy (with a total debt equal to 118% of *GDP*, almost twice the reference value of 60%)[18] slips back to 4th place with a debt per year of life nearly equal to 30,000 euro.

## 7. CONCLUSION

The framework of potential demography allows the calculation of both the demographic asset of a country and the dimensions of the components that contribute to, form, and maintain it annually.

In the ranking by share of the EU demographic asset as well as by share of population, Germany, the United Kingdom, France, and Italy are the main countries. However, with regard to the share of demographic asset, France and the United Kingdom improve their performances, while Italy holds its figure and Germany ends up being penalized.

In general, France, the United Kingdom, and Spain (with Ireland and the

[18] The reference value fixed by the excessive deficit procedure.

Netherlands to a lesser degree) appear to gain when using the potential demography approach. On the other hand Germany, Romania, Italy, Bulgaria, Hungary, and Poland are disadvantaged when using this approach.

Considering the additional contribution to *DA* (the $_{d}GDP$) in 2010, all countries except Lithuania show positive values. In particular, the increase generally observed in wealth (in per capita terms) is higher for Sweden, Belgium, the United Kingdom, and France. As for the relative positions of the major countries with respect to *DA* (i.e. France, the United Kingdom, Germany, and Italy), Germany regresses along with Italy behind the United Kingdom and France. Even though these last two countries are responsible for 30% of the demographic *GDP* of the European Union, their contribution is significantly different in nature. The contribution of new cohorts reaches the highest proportion in France (93%) while the contribution of net immigration flows reaches its highest value in the United Kingdom (15%).

The *DA* in France is strictly connected to fertility levels, whereas the *DA* of the United Kingdom appears to be much more influenced by migration flows. However, these results can be affected to some extent by short-term factors, such as the effects of the migration policies adopted, while the outcomes of fertility policies are less variable. Therefore, on this basis, it can be argued that the French $_{d}GDP$ has a greater stability than the British one because it fluctuates less. In this respect, Italy's $_{d}GDP$ stands out because of the far higher share of net migration (16%), which therefore results in the most "fragile" $_{d}GDP$.

Nevertheless, a positive contribution of net migration should be considered desirable, especially when a high fertility contribution is compensated by the loss due to negative migration balance, as happens in the case of Ireland.

Looking at the annual balance between production and consumption/loss of years of life, a total negative balance of 22 million years is apparent across the entire European Union.

In particular, some countries show seriously critical values in maintaining their asset over coming years. Notably, a negative balance is detected for the German population (-19 million years of life) and for the majority of eastern European countries. Since the negative balances are attributable almost entirely to the aging process (as the mortality differentials among the European countries are negligible)[19], this again suggests that sustaining fertility and net migration (that usually provide for young population) help to counterbalance the negative effects of aging.

In this evaluation of the economic performance of the 27 European countries using the tools of potential demography, some significant results emerged. Regarding the ratio between debt and *DA* among the European countries, Ital-

[19] At least in the more densely populated age classes.

ians (who show the worst performance) have to pay approximately 2 euro per day of their life, 30 cents more than Germans, twice as much as Swedes, and 38 times the debt of Estonians (the best performers).

However, the Italian position in comparison to the German one improves thanks to the contribution of immigration when the gross government debt (*GGD*) over $_{d}GDP$ is considered instead of the usual ratio over *GDP*. The annual debt born by Italians of the (net) cohorts amounts to 30,100 euro (7,900 of which can be attributed to net migrants), less than that of Germans (33,000), as well as the Greeks (35,600) and Irish (33,100).

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